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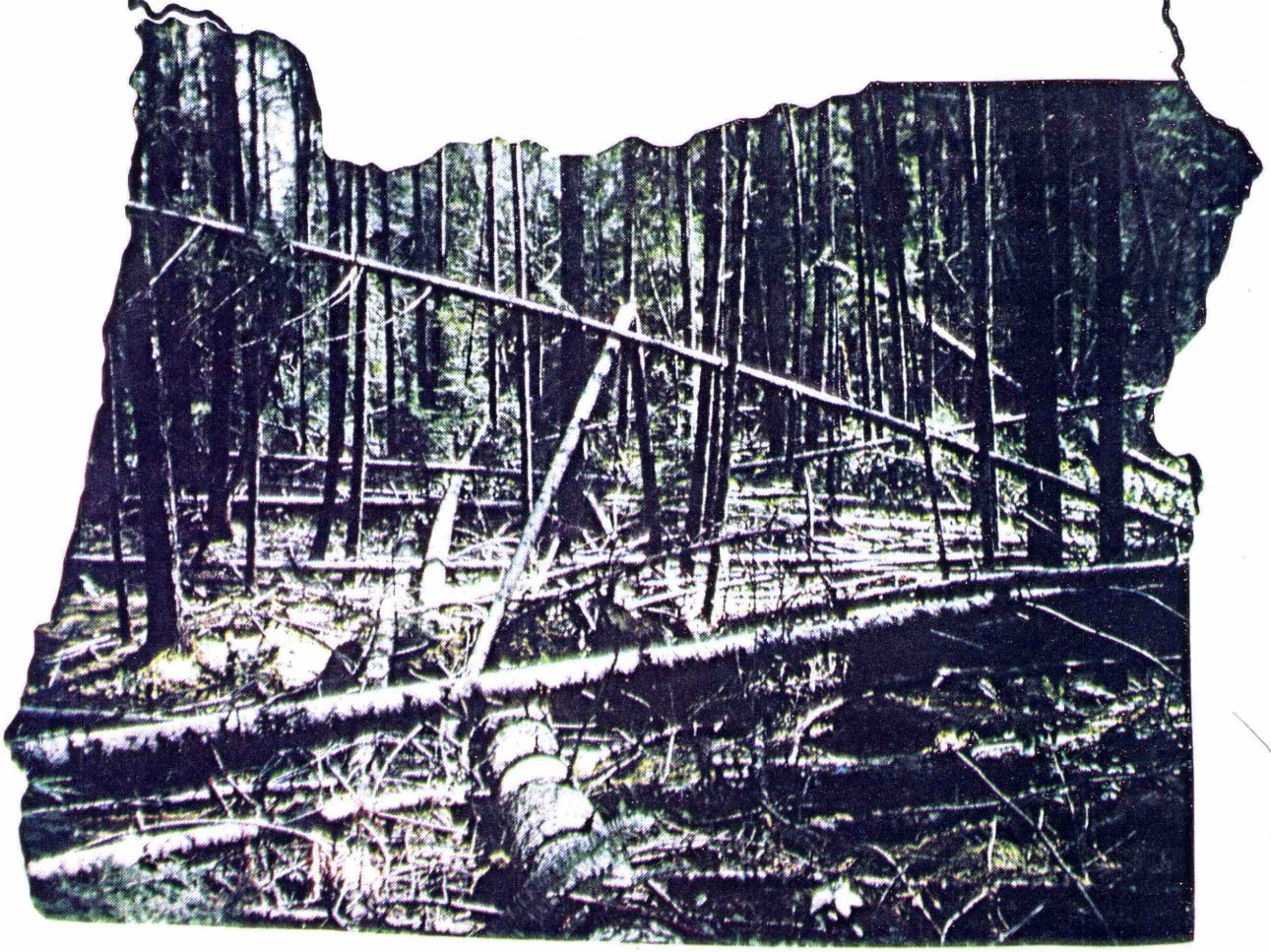
Forest Pest Management
Pacific Northwest Region

FOREST PEST EVALUATION

HAGAR CREEK AREA

PACKWOOD RANGER DISTRICT

GIFFORD PINCHOT NATIONAL FOREST



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FOREST PEST EVALUATION
HAGAR CREEK AREA
PACKWOOD RANGER DISTRICT
GIFFORD PINCHOT NATIONAL FOREST, WASHINGTON

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INTRODUCTION

On October 22 and 23, 1984, Forest Pest Management personnel did a forest pest survey of the Hagar Creek stand (T. 13 N., R. 9 E., secs. 22, 26 and 27), Packwood Ranger District, Gifford Pinchot National Forest (Figure 1). A prescription will be written for this stand as a requirement for silviculture certification by Ron Pfeifer, of the District. As a result of observations in the area, Ron suspected a high incidence of root disease in this stand and requested a biological evaluation to determine distribution and intensity of damage and to provide pest management recommendations.

Site and Stand Characteristics

The 38-acre Hagar Creek stand is located just above the Cowlitz River floodplain, 3/4 of a mile southeast of Packwood, Washington. Elevation ranges from 1200 to 1680 feet. Aspect is mainly west with some northwest exposure. Topography is moderate, averaging 20 to 25 percent over most of the unit but the upper or southeast portion of the block has somewhat steeper ground, with slopes approaching 50 to 60 percent. The block is bounded by Hagar Creek, another small intermittent stream, private property, old growth and a young plantation. Soils are very light and porous, containing a large proportion of volcanic tuff. Site quality is good.

The current stand on the site is an almost pure Douglas-fir plantation which was planted in 1953 following a clearcut harvest and broadcast burn. Planting stock and planting quality were both excellent. Apparently, stock was from a local seed source. Hardwoods common to the area include red alder, bigleaf maple, and black cottonwood. Hardwoods predominate in two marshy areas, encompassing about two acres. The original stand, similar to adjacent old growth, was predominantly Douglas-fir, with lesser amounts of western hemlock, western white pine, and western redcedar. The original stand was reportedly logged with a cable system and then tractor skidded one-half mile to the Packwood Lumber Company Mill. Numerous roads and skid trails within the unit indicate that it may have been tractor yarded as well.

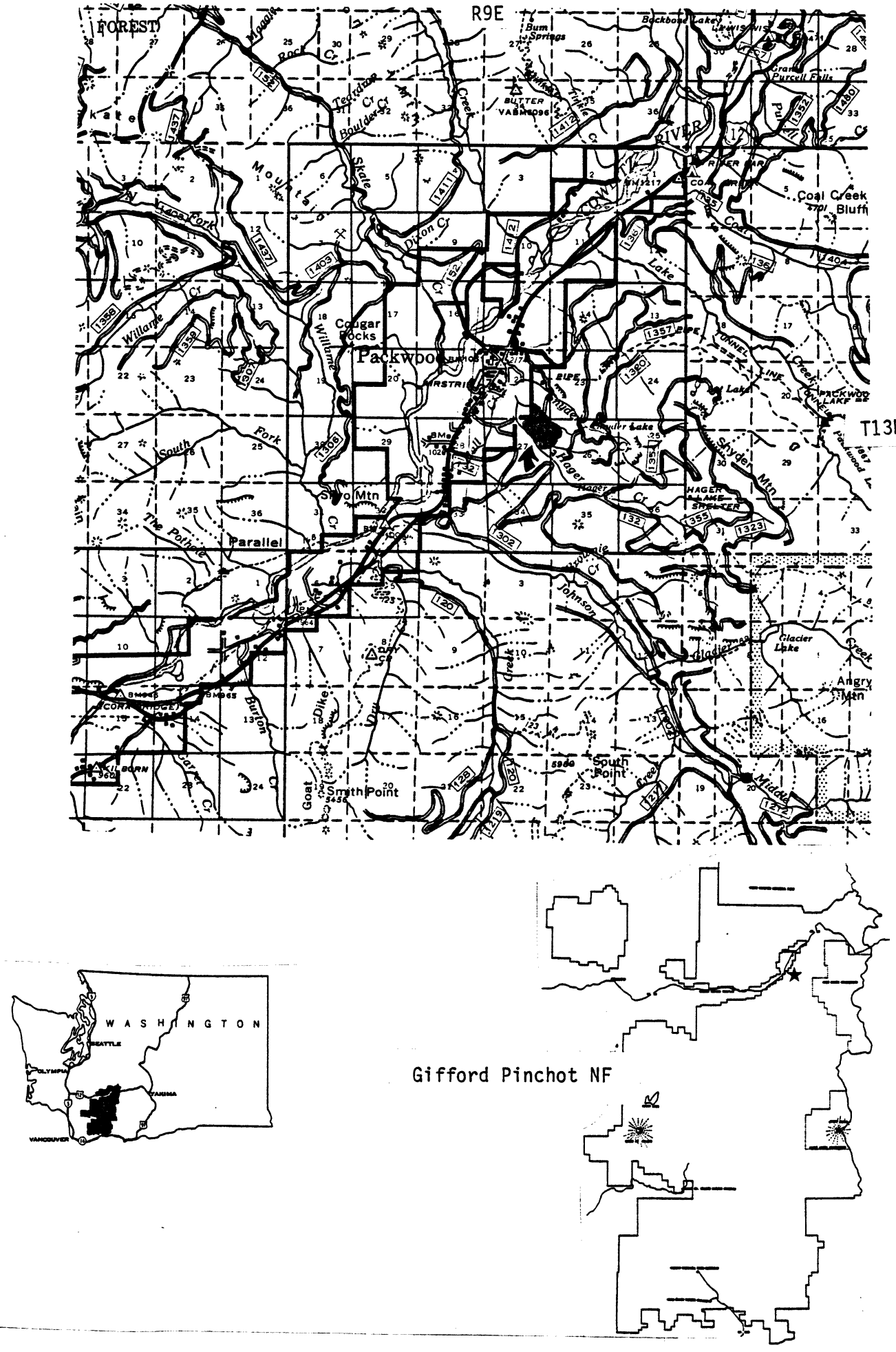

Figure 1. Maps depicting location of the Hagar Evaluation (shading), Packwood Ranger District, Gifford Pinchot National Forest

METHODS

A systematic survey of the entire 38-acre block was accomplished by spacing variable radius plots (BAF 20) at 5-chain (330') intervals along transects located 3 chains (198') apart. A Spiegal-Relaskop was used to define trees in each plot. Each plot was inspected for dead, dying, and symptomatic trees with root diseases. Diagnosing pests on individual trees involved (a) removing a section of bark from the boles of dead trees to check for bark beetles or their galleries, and (b) exposing one or more large roots to check for stained wood or mycelia of root disease fungi. On plots where dead or symptomatic trees were identified, the following were recorded for only those trees: species, DBH, condition (dead or alive), and presence and identity of pathogen(s). A basal area count was then made of other trees in the plot. Every fifth plot was a "count" plot in which previously mentioned data were collected on all trees. From data collected at plots, mean basal area and number of trees per acre were calculated by species, DBH class, condition and, when appropriate, cause of decline or death. Difference in basal area stocking between diseased and healthy plots was also determined.

In addition to taking plot data, surveyors scrutinized the entire survey area for pest-caused mortality. This was done by reconnoitering a 1-1/2-chain-wide strip on either side of the transect. Root disease centers were mapped with boundaries based on the furthest extent of dead or symptomatic trees. This information was used to make a composite map of the area (Figure 2).

RESULTS AND DISCUSSION

The survey revealed extensive root disease in the Hagar Creek block. Laminated root rot, caused by Phellinus weirii, was the most common disease present. Damage occurring as mortality and understocking in disease centers was found throughout most of the survey block. A minor amount of Armillaria root rot, caused by Armillaria mellea, was found on occasional scattered trees and in several small centers. One tree with black stain root disease, caused by Ceratocystis wageneri, was found. Mean basal areas and number of trees per acre are shown in Tables 1 and 2. At least nine percent of the Douglas-fir basal area is either dead, or live and infected with laminated root rot. Difficulty in detecting signs or symptoms of the disease on all but severely infected trees results in underestimates of numbers of these trees. Plots with at least one dead or laminated root disease infected tree had 92 percent as much basal area as healthy plots.

Most centers of laminated root rot were small (Figure 2) and expanding. In most areas, more living infected trees were detected than dead trees. Several centers were found that had only one or no dead trees but several infected ones. Other laminated root rot centers are still developing and these will not be apparent for another 10 to 15 years.

Armillaria root rot was not found on any plot trees. It was found only in between-plot reconnissance. Damage due to this disease was minimal. One small center of several trees was found. Occasional single tree mortality also was observed.

DISEASE BIOLOGY AND IDENTIFICATION

Laminated Root Rot

Laminated root rot is a common disease in Pacific Northwest stands. In western Washington and Oregon, this is the most damaging disease in Douglas-fir stands. Most losses are due to mortality. Other losses include growth loss of infected trees and continuing loss of productivity within disease centers.

Variability in species susceptibility exists in western Washington and Oregon mixed-conifer stands. In the survey area, the most susceptible species is Douglas-fir. Other species are less susceptible to infection and resulting mortality; western hemlock is intermediately susceptible, western white pine is tolerant, western redcedar is resistant, and all hardwoods are immune.

Phellinus weirii can survive as a saprophyte for 50 years or more on dead host material (large roots and stumps). New infections occur when roots of susceptible trees contact this material. Once infection has occurred, the fungus will grow along the root system and may spread to adjacent trees via root contacts or grafts. Disease centers thus develop and expand as more trees become infected. The rate of expansion can be as much as 1 to 2 feet per year. If nonsusceptible species make up significant stocking, this rate will be less. Damage can be serious when severely infected stands are cut and regenerated to susceptible species.

Laminated root rot can be identified from a variety of signs and symptoms. The disease usually causes patches or groups of dead and dying trees in pole-sized or larger stands. In younger stands, infection and mortality may be more scattered, in less apparent patches. Infected trees exhibit crown symptoms including reduced height growth, thinning, and chlorotic foliage, and an abnormal "distress" crop of abundant smaller-than-normal cones. Usually trees will be infected severely before crown symptoms are apparent. Such trees are prone to windthrow. Disease patches usually will appear as pockets of dead and down trees with infected trees exhibiting crown symptoms around the periphery. Less susceptible tree species may proliferate in disease centers. In older stands, less susceptible, shade-tolerant species such as western hemlock and western redcedar may fully stock disease pockets, obscuring evidence of laminated root rot. In young, relatively pure Douglas-fir stands, hardwoods, especially maples, often become established in disease centers. In these stands, patches of hardwoods are usually visible and indicate areas that should be investigated for other signs or symptoms of root disease.

Diseased windthrown trees will frequently exhibit "root balls"; remnants of the root systems that are decayed and broken off just below the root collar. Exposed decayed wood will usually have characteristic delaminations along the annual rings, as well as pitting, and growth of reddish-brown setal hyphae between the sheets of decayed wood (Plate 1).

LOCATION OF ROOT DISEASES

HAGAR AREA

PACKWOOD RD

GIFFORD PINCHOT NF

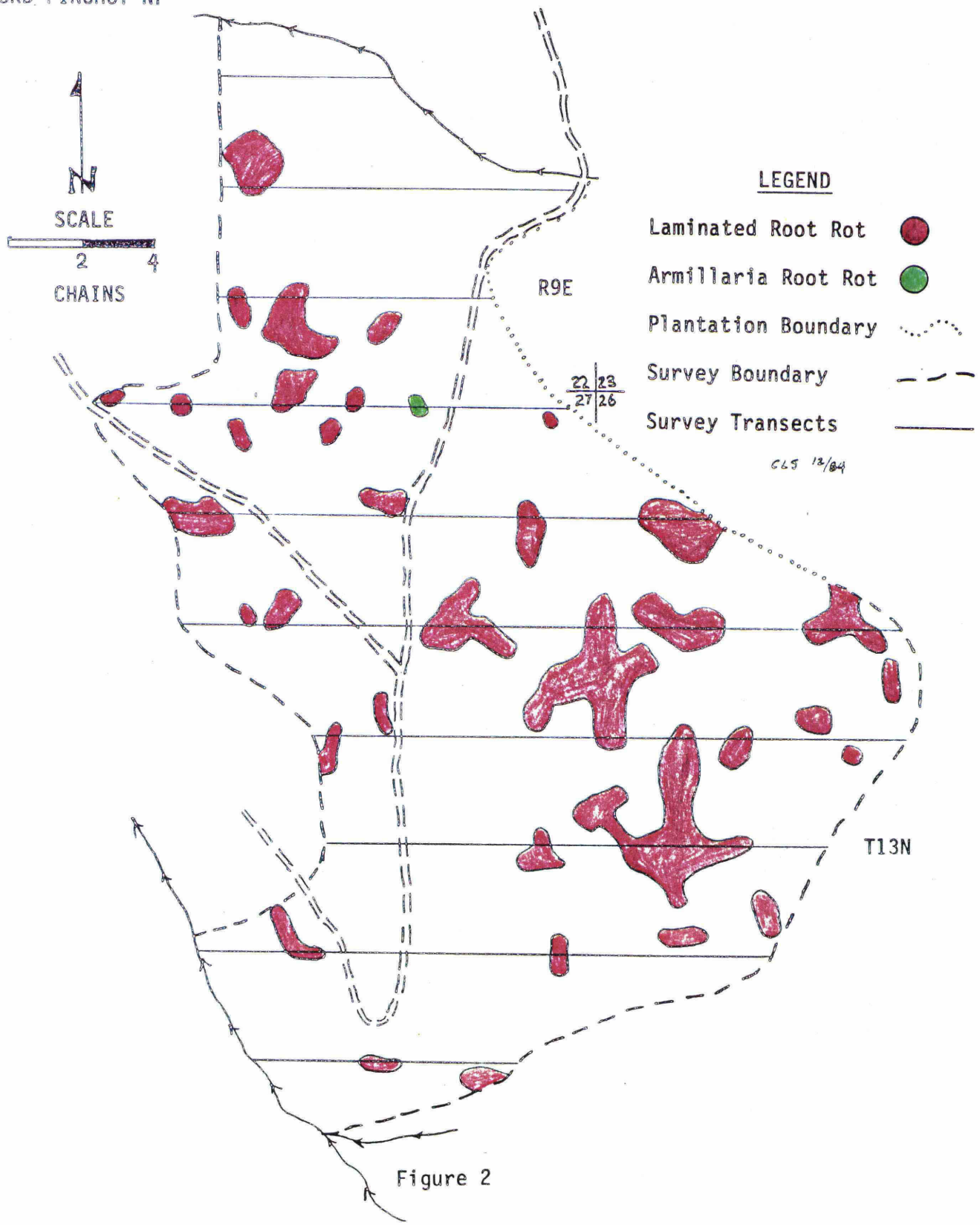

Figure 2

Armillaria Root Rot

Armillaria root rot is found throughout the Northwest on a variety of hosts. In western Washington, this disease is found most commonly in plantations, especially where offsite stock was planted or local stock was poorly planted. Stressed trees of most species and all age classes are susceptible to attack. Douglas-fir is most susceptible when it is less then 30 years old. Occasionally, virulent strains of this fungus cause mortality to more than one species and age class on a site. In most cases, Armillaria mellea will be damaging to only one species in a stand.

As with laminated root rot, A. mellea can cause group mortality. Disease spread is similar, occurring across root contacts or grafts. Infective string-like fungal structures called rhizomorphs can also grow for up to 5 feet through the soil and cause infection. In most cases, this disease causes scattered mortality. Most often, centers are small.

Crown symptoms caused by Armillaria root rot often include chlorotic foliage and/or a distress cone crop. Resinosis around the base of the bole is very common. White-to cream-colored mycelial fans are usually found growing under the bark of the lower bole on the root collar and roots of infected trees (Plate 2). These can also be found on trees that have been dead for up to 3 years. Rhizomorphs may also be found growing on the exterior of infected roots of dying or recently killed trees. On trees that have been dead several years, rhizomorphs may be found under the bark of the lower bole and root collar.

Black Stain Root Disease

In the Northwest, black stain root disease most commonly causes mortality in young Douglas-fir plantations. Occasionally, older firs will be attacked. This disease usually is found on sites that have been tractor logged, in stands which have been thinned, and along roads and skid trails.

Mortality due to this disease occurs in patches that often show evidence of rapid expansion. Dead standing trees are often present with dying chlorotic trees occurring on the periphery.

Black stain is a vascular wilt rather than a root rot. Initial infection involves spread by species of bark beetles and weevils that feed on roots. Following infection, disease spreads from tree to tree via root contacts. Following host death, the fungus dies.

Black stain disease can be identified by cutting into the roots and root collar and finding the black- to chocolate-brown-colored stain in the sapwood.

ALTERNATIVES AND MANAGEMENT RECOMMENDATIONS

Laminated root rot is by far the most significant pest problem in the Hagar Creek area at present. Armillaria root rot has caused small losses in the past and black stain root disease was found on one tree. Future losses due to the latter two diseases should be minimal. As the stand grows older, other diseases and insects that are more commonly found in such older age classes may start to appear.

At this time management strategies aimed at reducing current and future losses due to laminated root rot should be formulated. The following is a list of alternatives:

Defer Treatment Option

The stand is currently at an age where a commercial thinning entry is logical. Since this stand was not precommercially thinned, overstocking is limiting growth rates somewhat. A commercial thinning would generate wood products and improve growth on crop trees. However, the high level of laminated root rot in this stand makes a commercial thin entry somewhat risky. By deferring treatment for another 15 to 20 years, the following can be anticipated:

(a) Disease centers will continue to appear for a few more years and those already evident will spread at a rate of 1 to 2 feet per year.

(b) Losses directly associated with root diseases will steadily increase. Disease-induced windthrow will be minimized as a result of keeping the stand closed.

(c) Determining location of disease centers will be somewhat easier, especially those just now appearing, so when treatments are made, maximum percentages of infected ground can be treated.

(d) Opportunities for managing other species within root disease centers will diminish as the stand matures.

(e) Opportunities to salvage mortality are reduced because of limited access.

(f) Yield, especially board foot, is reduced.

(g) Level of inoculum in the soil will continue to grow, increasing the costs involved in treating the problem.

The defer treatment option would simplify disease management strategy by combining all site treatments in a single, late commercial thin/clearcut harvest.

Disease Management Option

This option would employ disease management strategies during first and second commercial thinning entries. The strategy is to remove trees and regenerate infection centers with less disease-susceptible species in both intermediate entries by combining commercial thinnings with small clearcuts.

Laminated root rot can be treated most effectively prior to stand reestablishment. Following harvest of the existing stand, or portions of it, less-susceptible species must be planted or infective material on the site removed if disease losses are to be minimized.

Regenerating less susceptible species within disease centers will minimize future losses. Planting IMMUNE--bigleaf maple, red alder; RESISTANT-- western redcedar; or TOLERANT--western white pine, will minimize future losses and

perpetuation of infective material in the soil. Following at least a 50-year rotation of such species, excluding susceptible species, Douglas-fir could be safely regrown. Western hemlock, a tree intermediately susceptible to P. weirii, can be grown in disease centers with minimal loss over a rotation; however, trees may become infected, and some continuing infection hazard may be present following harvest of that stand. As far as stand management is concerned, that hazard is at an acceptably low level.

When susceptible species, such as Douglas-fir, are replanted in disease areas either to satisfy management objectives or because of a lack of alternative species, the site must be treated to avoid unacceptable losses. Stump removal can be accomplished with machinery or explosives. Possible soil disturbance and compaction, soil nutrient drain, high costs, and steep topography are drawbacks to stump removal.

Recommended management action is to use species manipulation to gradually reduce P. weirii levels in this stand. Implementing this option involves the following.

A. Determine the areas to be treated in this entry.

Figure 2 shows the location of already apparent disease centers. Decisions must be made whether to treat individual centers, smaller consolidated groups of centers, or one or two large areas containing the highest level of disease. We recommend treating consolidated groups or larger areas. The main benefits of this approach are to minimize costs and to capture most of the yet undetected infection which is probably concentrated in and around visible centers.

Treatment areas and buffers of 30 to 40 feet beyond the last visibly infected tree on the perimeter of centers should be clearcut. This is done to include trees which are infected but do not yet exhibit crown symptoms. The need to be concerned with this in presale layout is lessened when larger areas are treated. The remainder of the stand not in clearcut blocks should be commercially thinned.

B. Delineate diseased areas during or following timber harvest.

Where larger clearcuts are used it may be best to determine what specific areas within the blocks need to be planted to less susceptible species. It will be necessary to mark on-the-ground, perimeters of disease centers. For about 3 to 4 weeks after exposure red-brown stain, often crescent-shaped, usually is present on cut surfaces of infected stumps in the heartwood and the region between heartwood and sapwood (Plate 3). On trees which were severely infected, advanced decay will be present. Informal agreements with fallers are the most effective way of having infected stumps identified and marked. Usually a notch on the top surface is adequate. Planting of less susceptible species should extend 50 feet beyond the last visible detected diseased stump around the perimeter of centers.

If smaller treatment blocks are used, where mainly disease centers and buffers are clearcut, it is not necessary to check stump surfaces. The entire block should be planted to less susceptible species.

C. Regenerating diseased/nondiseased areas.

Following harvest and site treatment, the clearcut units within the stand should be replanted to species adapted to the site which will yield the highest return. Since a second age class is being created within a larger even-aged unit, it is highly desirable to select and manage for species which will provide a desirable product when the remainder of the stand is at age 100.

Douglas-fir probably provides the highest yields of all site-adapted species. This tree should be grown where possible. Where laminated root rot is present, a variety of other species are available, most of which can be managed for a product after approximately a 65-year rotation. These include western hemlock, western white pine, bigleaf maple and red alder.

A precommercial thinning in 10 to 12 years should be done to remove Douglas-fir volunteers from root disease centers.

D. Reenter stand in 15-20 years.

This would be a second commercial entry where remaining disease centers are identified and treated. An approach similar to the first entry strategy could be used. Main differences would be increasing buffer zones to 50 feet and selecting only very fast-growing species for planting in root disease areas.

By following this option, the following results can be anticipated.

a. Treated centers will be returned to productivity. Untreated and undetected centers will continue to enlarge.

b. Losses directly due to root diseases will diminish. Windthrow will increase because of stand opening; root rot-weakened trees will be especially susceptible.

c. Maximum time is allowed for growing and managing alternate species. More time is also allowed for infection levels to diminish.

d. By accessing the stand, root rot-induced windthrow and mortality can be readily salvaged.

Plate 1. Laminated decay and setal hyphae characteristic of Phellinus weirii

Plate 2. Mycelial fans characteristic of Armillaria mellea

Plate 3. Red-brown stain on a recently cut Douglas-fir stump, caused by Phellinus weirii. Note: Stain also frequently occurs in the heartwood center.

Other Diseases

Both black stain root disease and Armillaria root rot are present at low levels. Additional mortality is not anticipated to be significant. Both of these diseases are most severe in younger age classes. However, the following management recommendations will minimize the potential for future losses.

Armillaria Root Rot

The one center identified in the survey, along with a 30-foot buffer, should not be thinned. At the time of the second commercial entry, the situation should be reassessed to determine whether the disease is still active. If it is not, the center and buffer may be thinned. If the center is still active, patch cut the center and buffer and establish a fast-growing alternate species until the final harvest.

Use of superior planting stock and maintenance of stand vigor will minimize future armillaria root rot problems.

Blackstain Root Disease

A single tree was found infected with black stain root disease. This tree is within a buffer strip of a laminated root rot center. Future problems can be minimized by avoiding major site disturbances and soil compaction.

Table 1. Mean Basal Area (ft^2) and Trees per Acre by Diameter Class, Species and Tree Condition, Hagar Creek.

DBH Class	Douglas-Fir				Western Hemock		Western Redcedar	
	Alive		Dead		Alive		Alive	
	BA	T/A	BA	T/A	BA	T/A	BA	T/A
4	17	191	0	0				
6	21	105	2	10			3	17
8	42	118	1	2				
10	46	82	1	2				
12	9	11						
14	0	0			3	3		
16	3	2						
18								
20								
22					3	1		
Total	138	509	4	14	6	4	3	17

Table 2. Mean Basal Area (ft^2) and Trees Per Acre by Pest Condition, and Diameter Class, Hagar Creek.

DBH Class	Infected Living Trees Phellinus weirii		Infected Dead Trees Phellinus weirii	
	BA	T/A	BA	T/A
4	0	0	0	0
6	1	3	2	10
8	5	13	1	2
10	3	6	1	2
12	2	3		
14				
16				
18				
20				
22				
Totals	11	25	4	14